Abstract

Contemporary research in digital signal processing (DSP) is focussed on issues of computational complexity, very high data rate and large quantum of data. Thus, the success in newer applications and areas hinge on handling these issues. Conventional ways to address these challenges are to develop newer structures like Multirate signal processing, Multiple Input Multiple Output(MIMO), bandpass sampling, compressed domain sensing etc. In the implementation domain, the approach is to look at floating point over fixed point representation and / or longer wordlength etc., related to number representations and computations. Of these, a simple approach is to look at number representation, perhaps with a simple integer. This automatically guarantees accuracy and zero quantization error as well as longer wordlength. Thus, it is necessary and interesting to explore viable DSP alternatives that can reduce complexity and yet match the required performance. The main aim of this work is to highlight the importance, use and analysis of integer sequences. Firstly, the thesis explores the use of integer sequences as windowing functions. The results of these investigations show that integer sequences and their convolution, indeed, outperform many of the classical real valued window functions in terms of mainlobe width, sidelobe attenuation etc. Secondly, the thesis proposes techniques to approximate discrete Gaussian distribution using integer sequences. The key idea is to convolve symmetrized integer sequences and examine the resulting profiles. These profiles are found to approximate discrete Gaussian distribution with a mean square error of the order of 10^{-8} or less. While looking at integer sequences to approximate discrete Gaussian, Fibonacci sequence was found to exhibit some interesting properties. The third part of the thesis proves certain fascinating optimal probabilistic limit properties

(mean and variance) of Fibonacci sequence. The thesis also provides complete generalization of these properties to probability distributions generated by second order linear recurrence relation with integer coefficients and any k^{th} order linear recurrence relation with unit coefficients. In addition to the above, the thesis also throws light on possible architectural implications of using integer sequences in DSP applications and ideas for further exploration.